US009466912B2

(12) **United States Patent**
Matsumoto

(10) **Patent No.: US 9,466,912 B2**
(45) **Date of Patent: Oct. 11, 2016**

(54) **CONNECTOR**

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(21) Appl. No.: **14/515,354**

(22) Filed: **Oct. 15, 2014**

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Jun. 27, 2014 (JP) 2014-133000

(51) **Int. Cl.**

H01R 24/28 (2011.01)
H01R 13/44 (2006.01)
H01R 4/02 (2006.01)
H01R 107/00 (2006.01)

(52) **U.S. Cl.**

CPC ***H01R 13/44*** (2013.01); *H01R 4/028* (2013.01); *H01R 2107/00* (2013.01)

(58) **Field of Classification Search**

CPC ... H01R 13/44; H01R 4/028; H01R 2107/00
USPC 439/135, 693, 692, 884, 752
See application file for complete search history.

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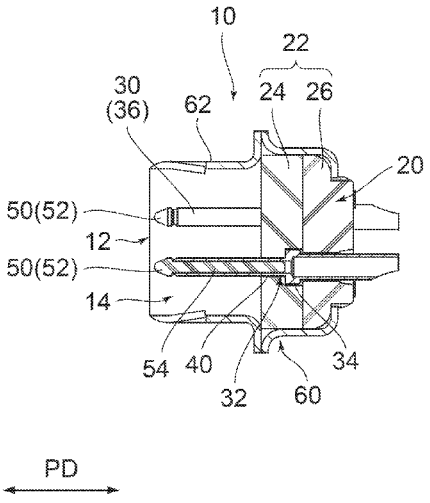
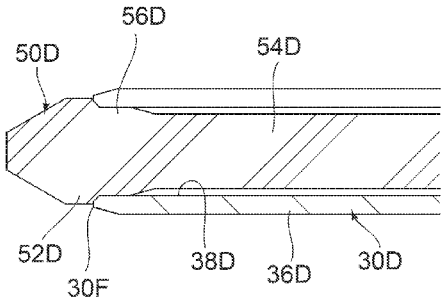
(57) **ABSTRACT**

A connector is mateable with a mating connector along a predetermined direction. The connector comprises a holding member, a plurality of contacts and a plurality of contact prevention members. The holding member includes a holding portion. The plurality of contacts include held portions and main portions, respectively. The held portions are held by the holding portion. The main portions extend from the held portions, respectively, in the predetermined direction. The main portions project over the holding portion in the predetermined direction. Each of the main portions has a tubular shape. Each of the contact prevention members is made of insulator. The contact prevention members occupy insides of the main portions, respectively. The contact prevention members project over the main portions, respectively, in the predetermined direction.

11 Claims, 15 Drawing Sheets





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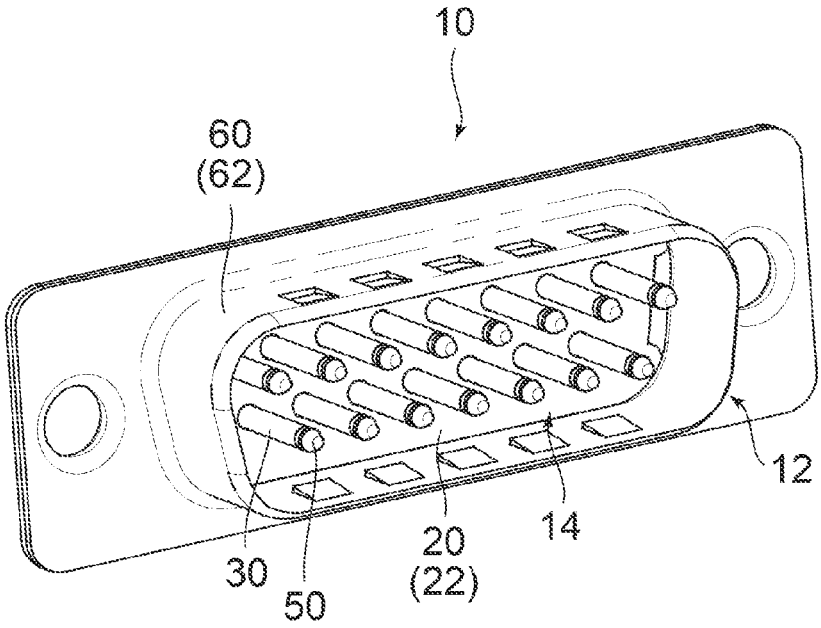
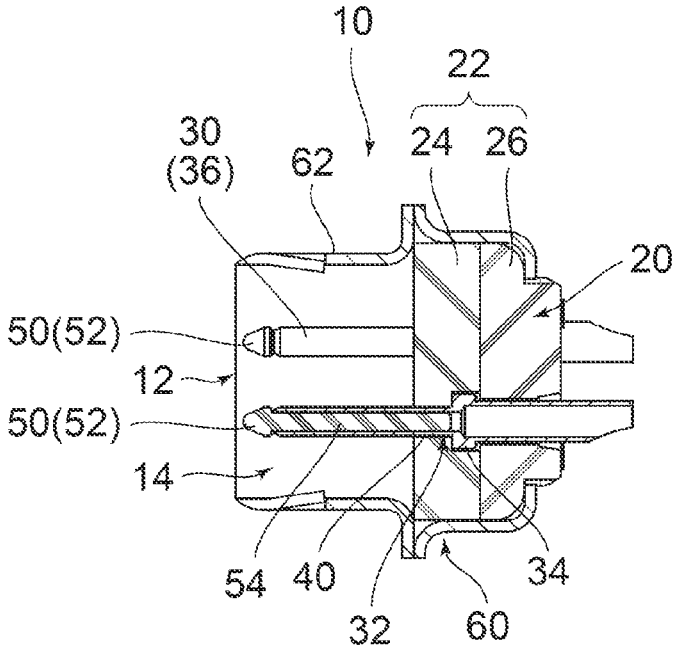

10
60
(62)
12
14
20
(22)
30
50

FIG. 1


10
22
30
(36)
62
24
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20
50(52)
12
50(52)
14
54
40
32
34
60

PD

FIG. 2

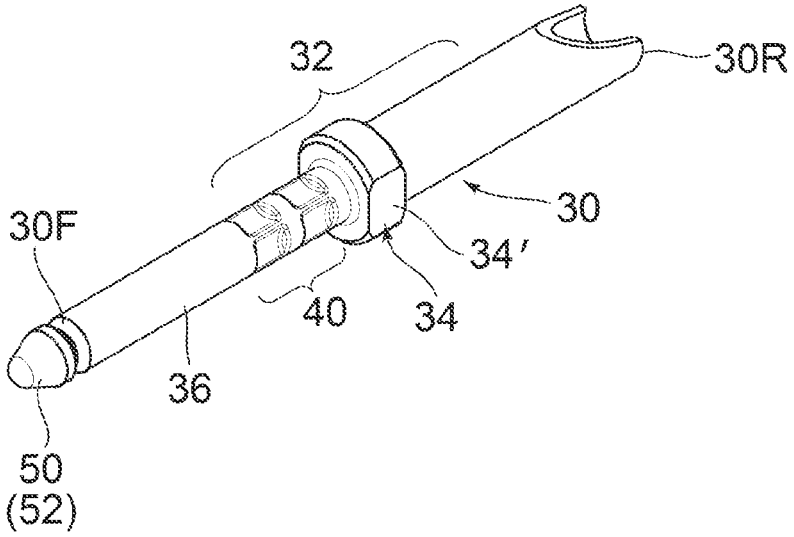


FIG. 3

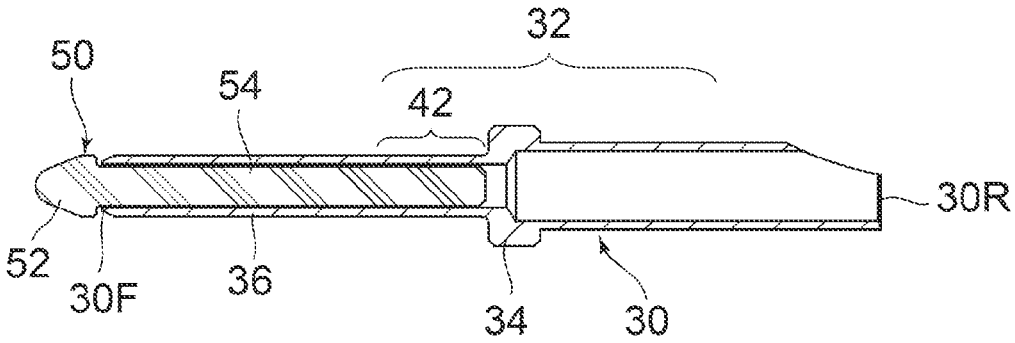


FIG. 4

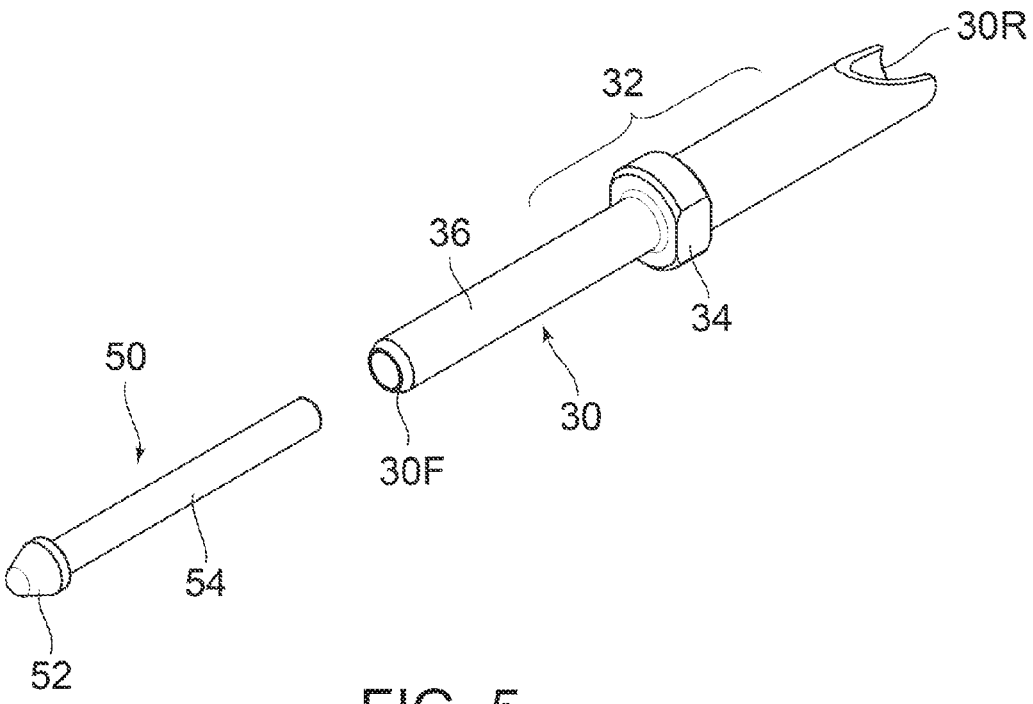
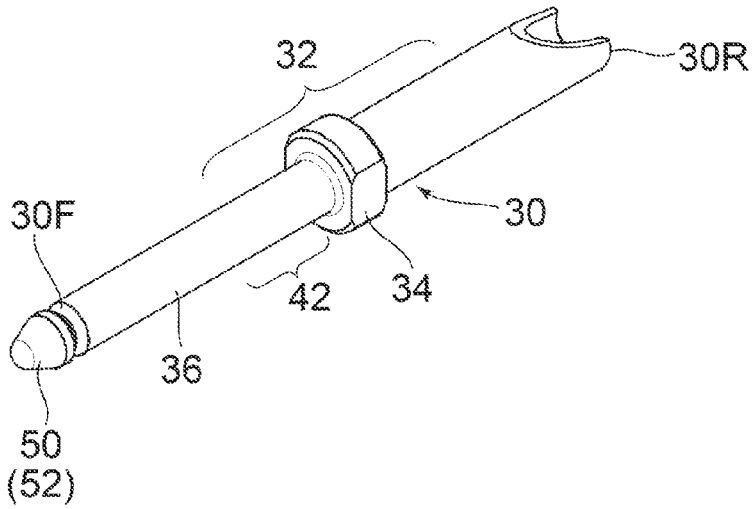


FIG. 5



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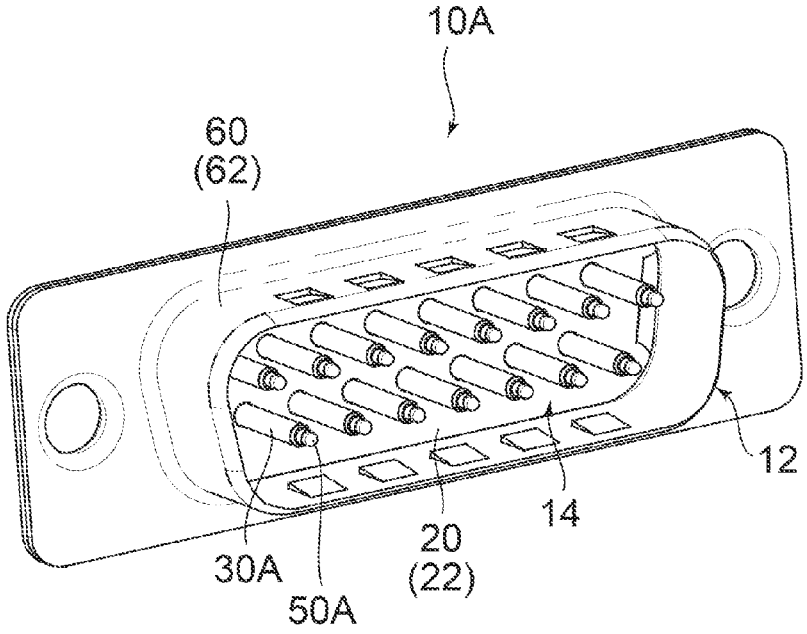
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60
(62)
12
14
20
(22)
30A
50A

FIG. 7

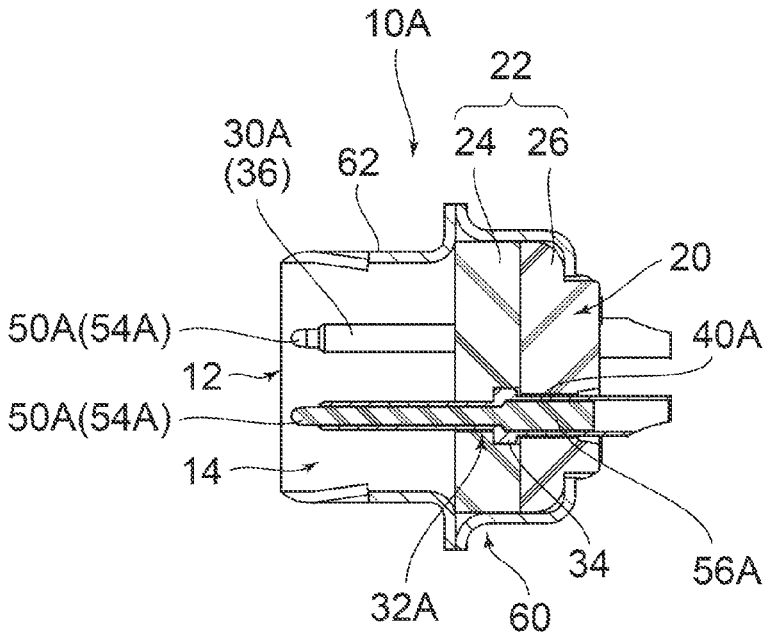
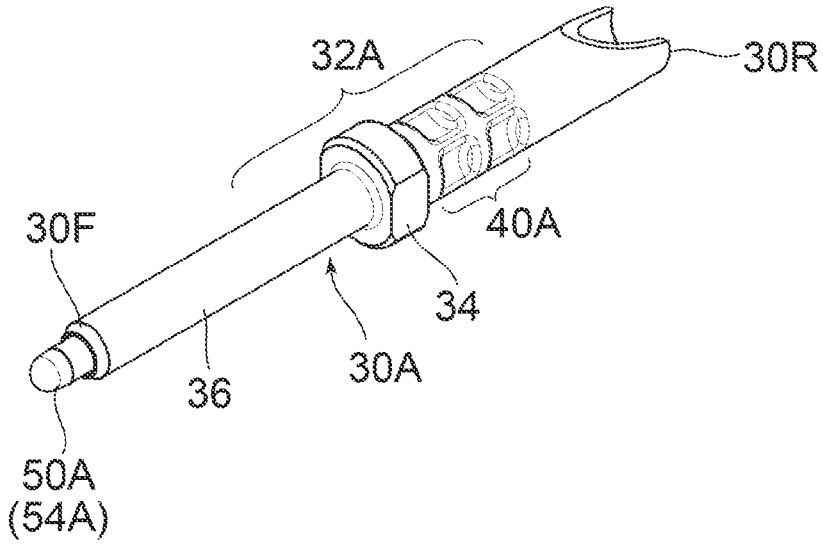

10A
22
30A
(36)
62
24
26
20
50A(54A)
40A
12
50A(54A)
14
34
56A
32A
60
PD

FIG. 8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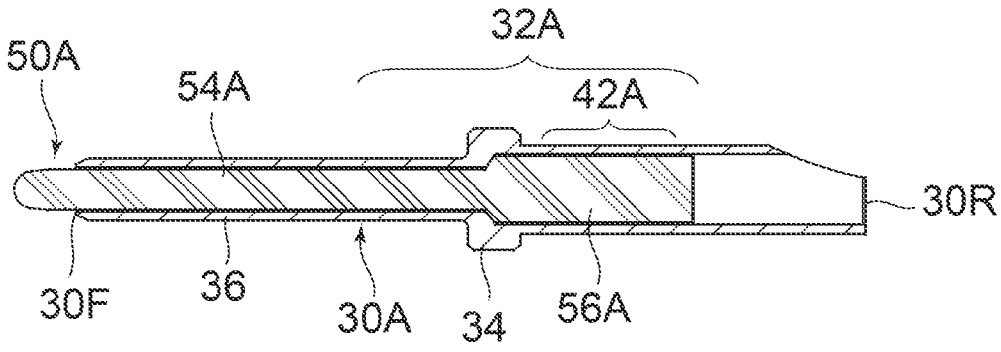
30R
30F
40A
34
36
30A
50A
(54A)

FIG. 9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50A
54A
42A
30R
30F
36
30A
34
56A

FIG. 10

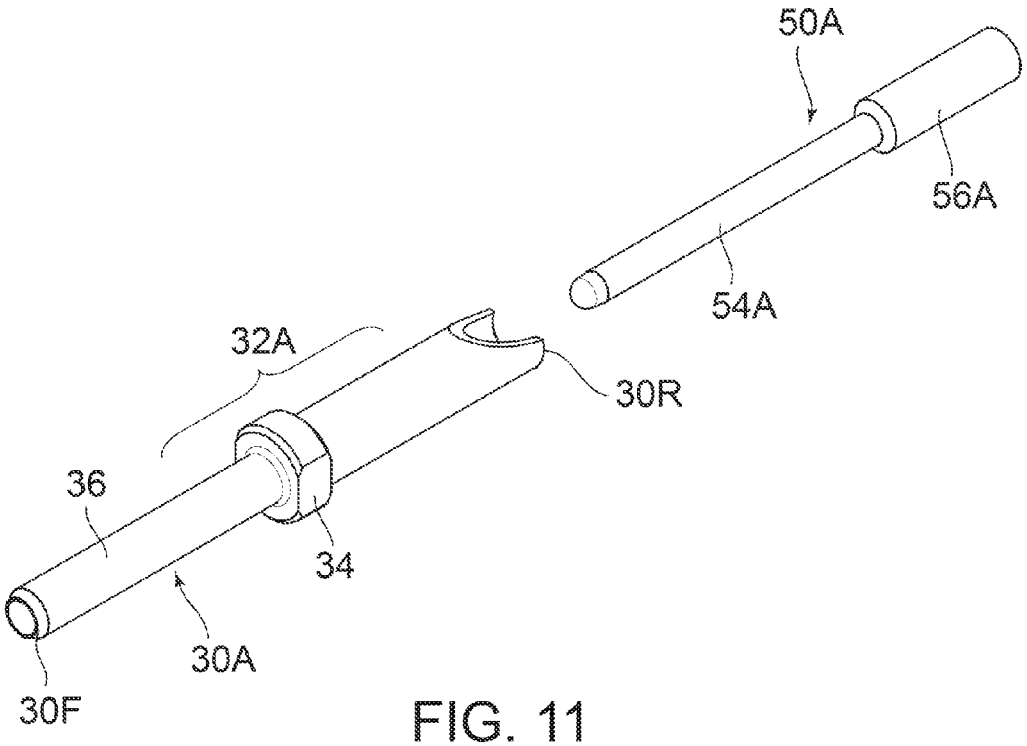
50A
56A
54A
32A
30R
36
34
30A
30F

FIG. 11

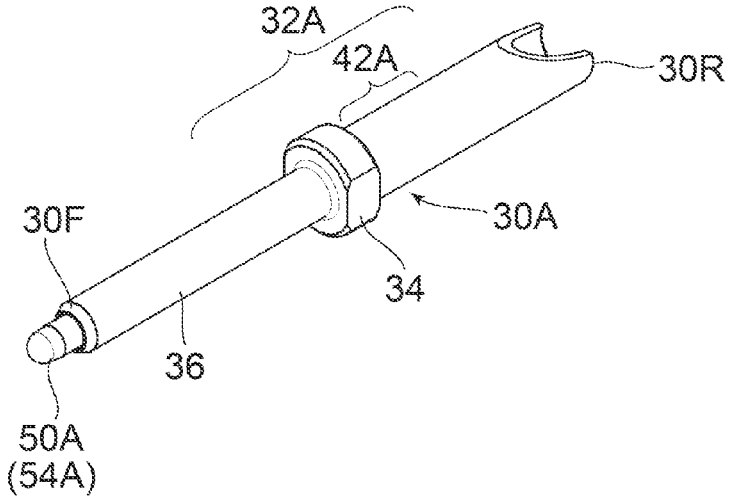
32A
42A
30R
30F
30A
34
36
50A
(54A)

FIG. 12

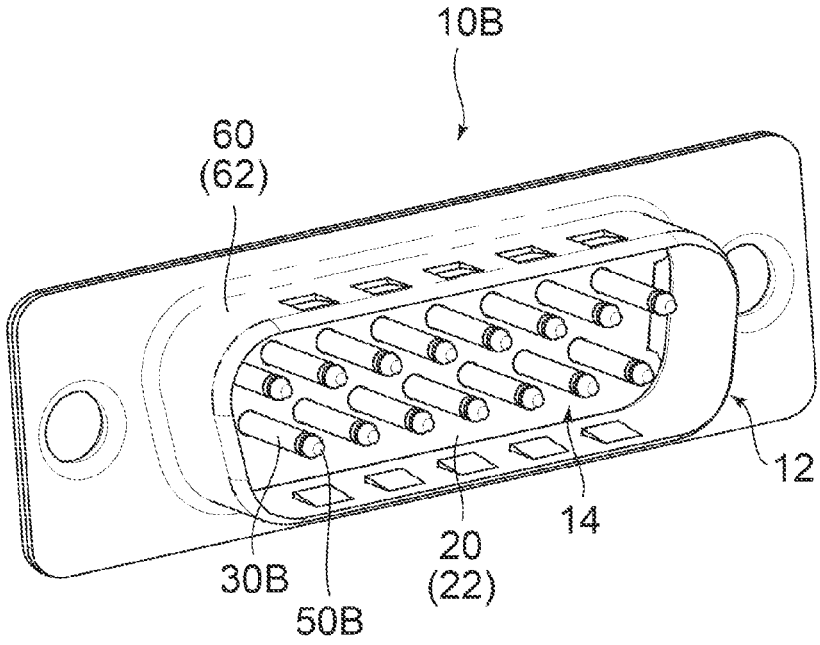
10B
60
(62)
12
14
20
(22)
30B
50B

FIG. 13

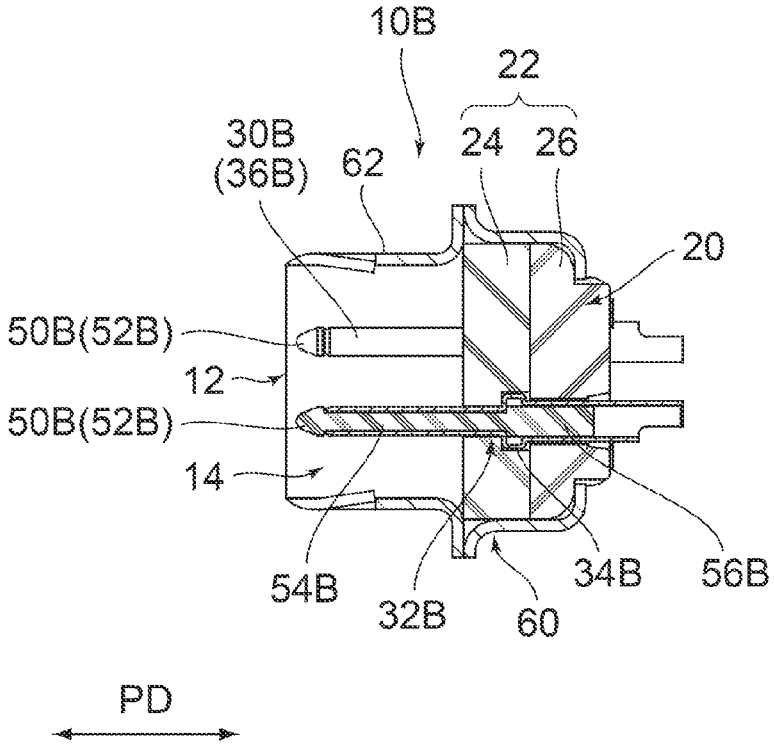
10B
22
30B
(36B)
62
24
26
20
50B(52B)
12
50B(52B)
14
54B
32B
60
34B
56B
PD

FIG. 14

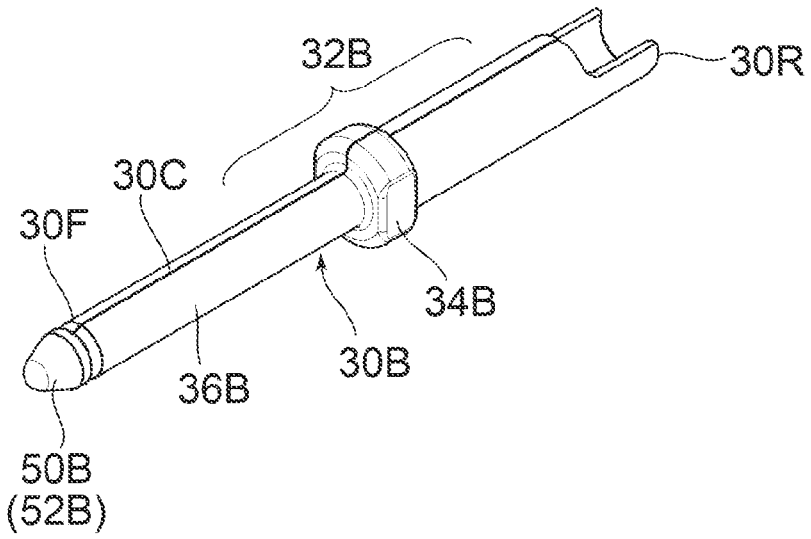
32B
30R
30C
30F
34B
30B
36B
50B
(52B)

FIG. 15

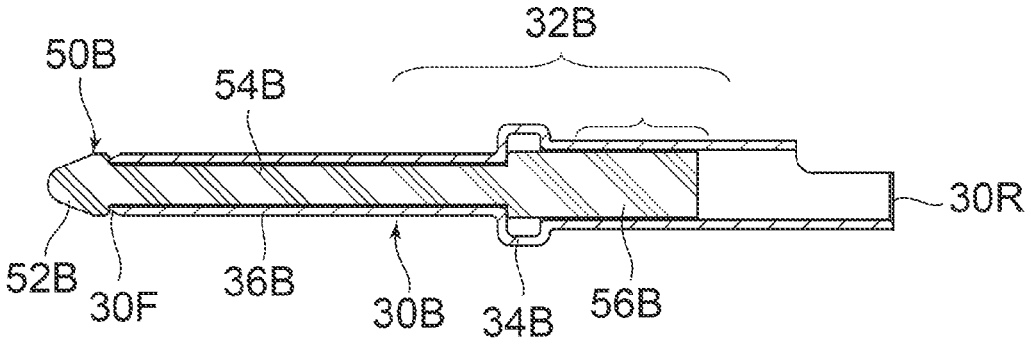
32B
50B
54B
30R
52B
30F
36B
30B
34B
56B

FIG. 16

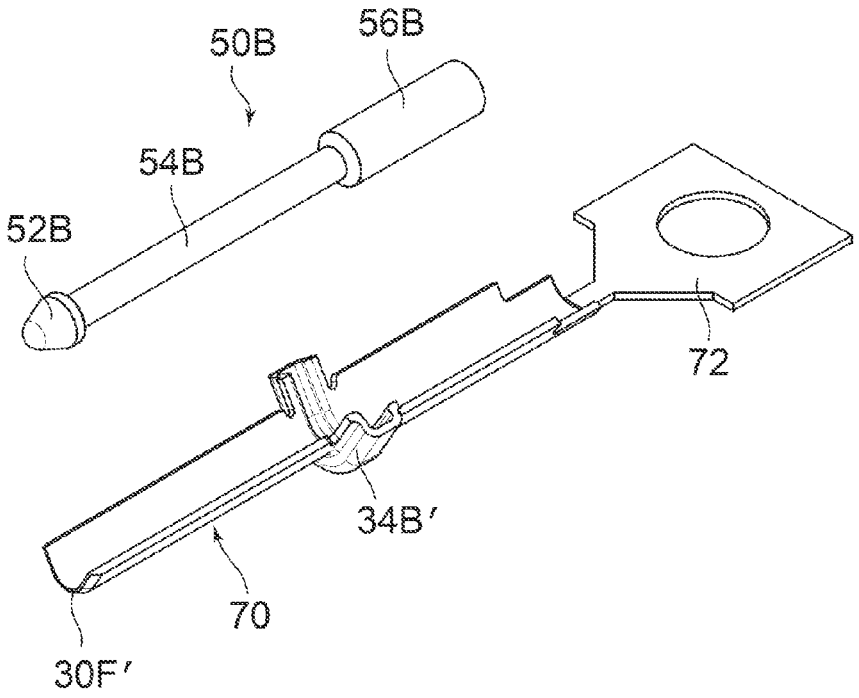

FIG. 17

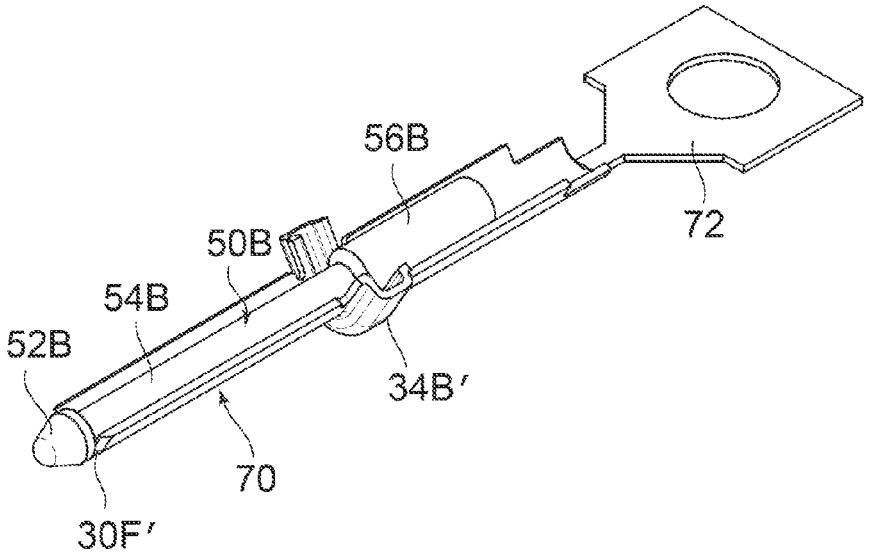

FIG. 18

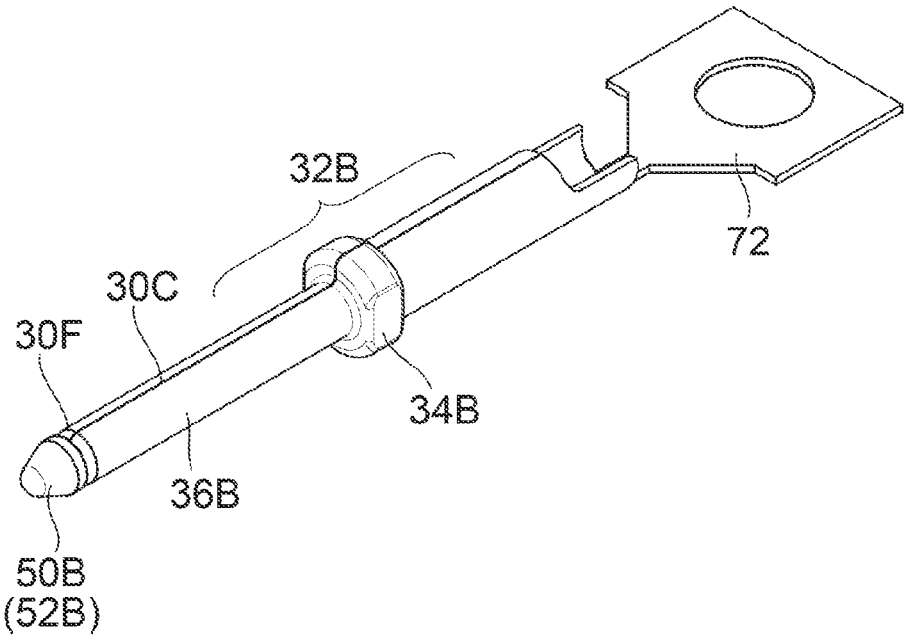

FIG. 19

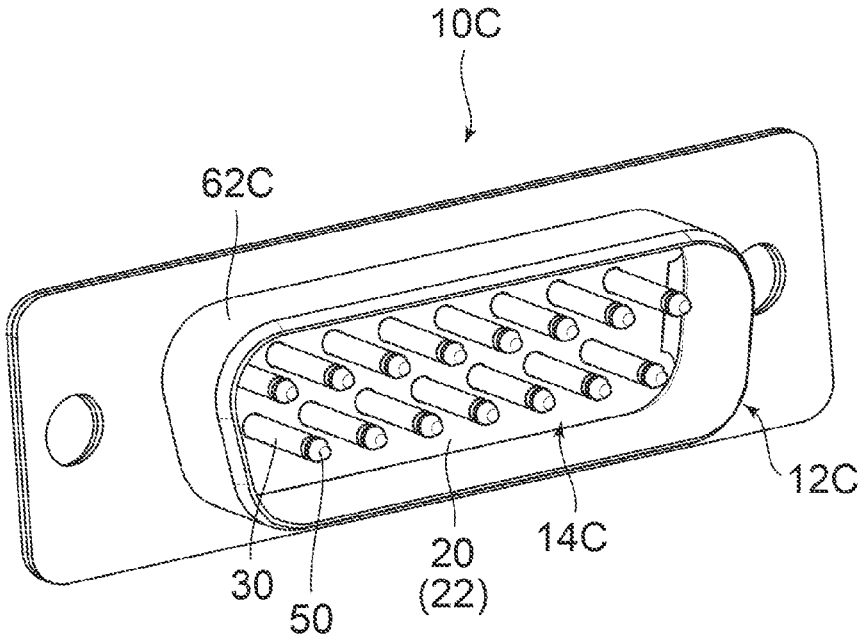

FIG. 20

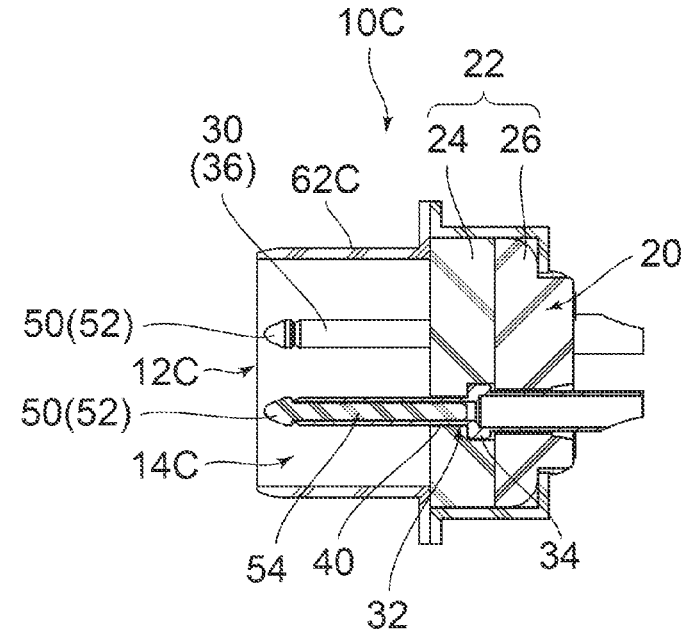
10C
22
24
26
30
(36)
62C
20
50(52)
12C
50(52)
14C
54
40
32
34
PD

FIG. 21

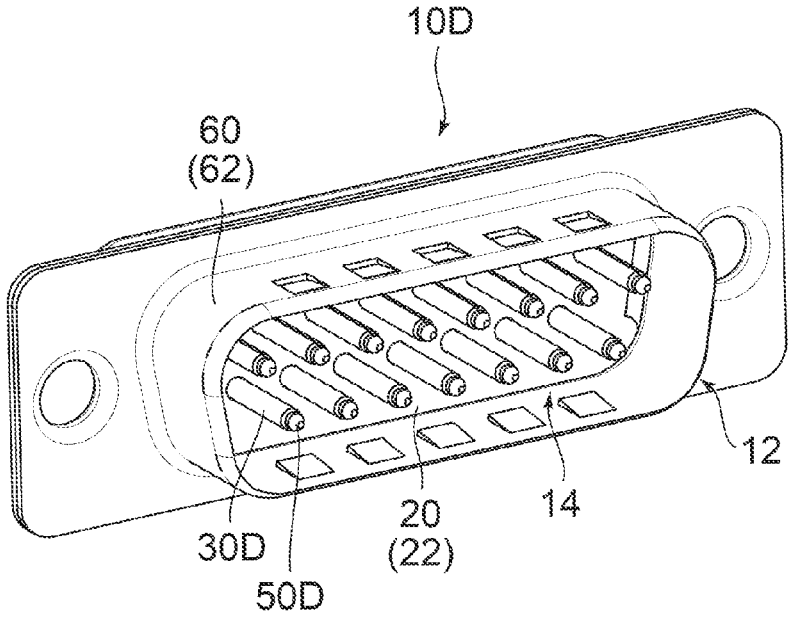
10D
60
(62)
12
14
20
(22)
30D
50D

FIG. 22

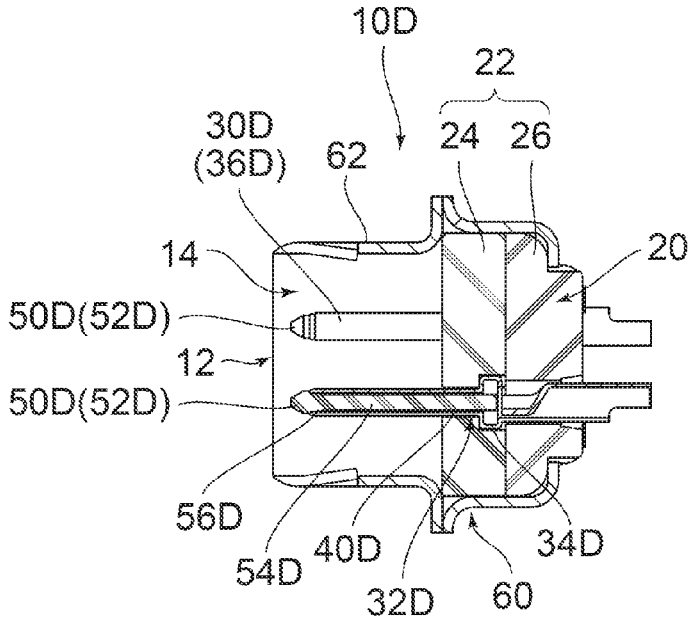
10D
22
30D
(36D)
62
24
26
14
20
50D(52D)
12
50D(52D)
56D
54D
40D
32D
60
34D
PD

FIG. 23

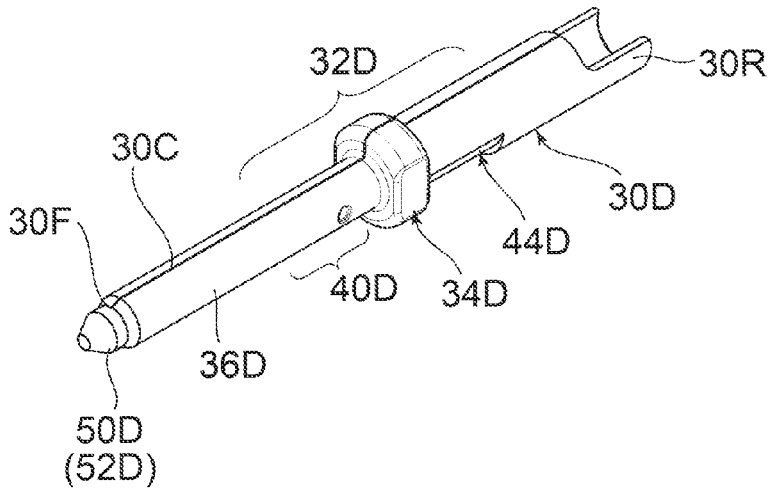
32D
30R
30C
30D
30F
44D
40D
34D
36D
50D
(52D)

FIG. 24

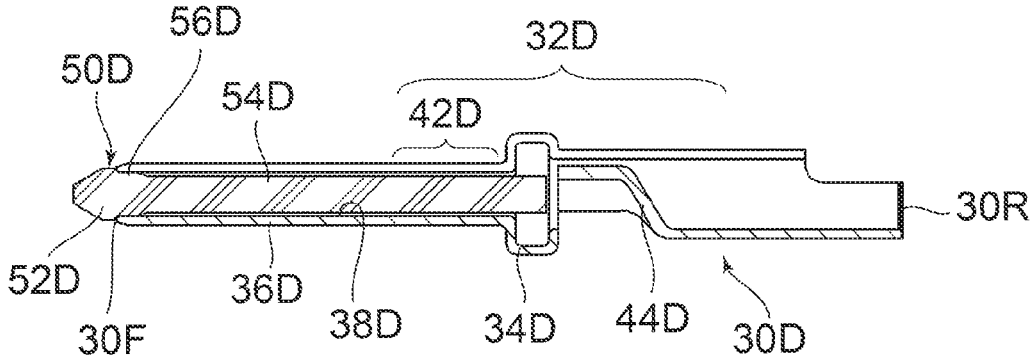
56D
50D
54D
32D
42D
30R
52D
36D
38D
34D
44D
30D
30F

FIG. 25

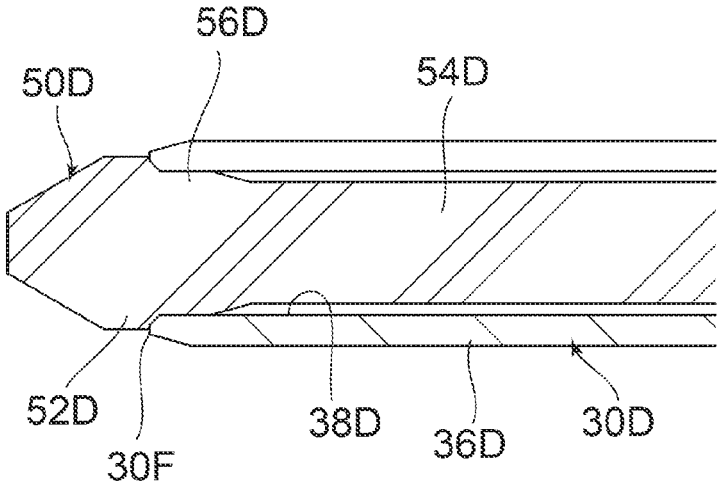
56D
50D
54D
52D
30F
38D
36D
30D

FIG. 26

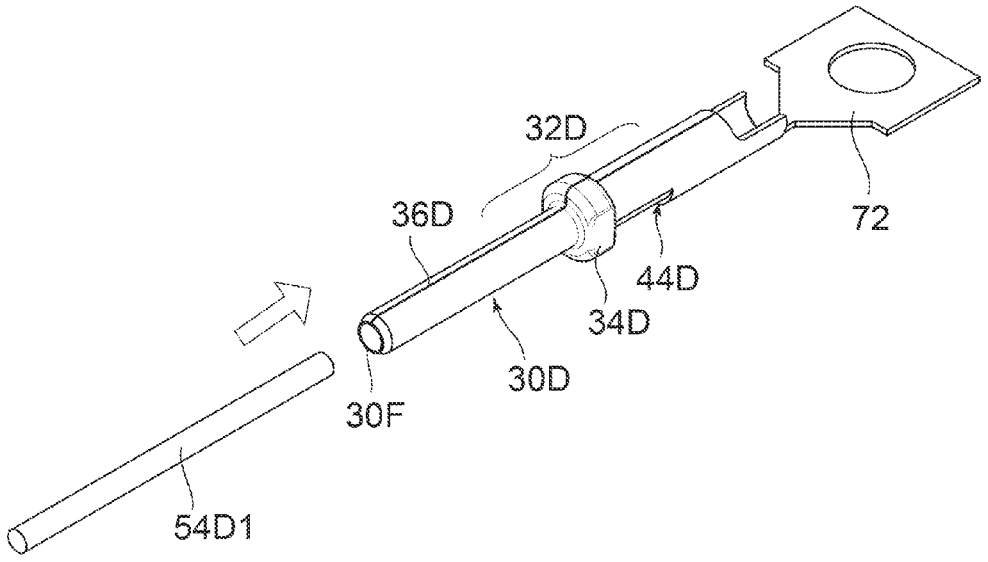
32D
36D
72
44D
34D
30D
30F
54D1

FIG. 27

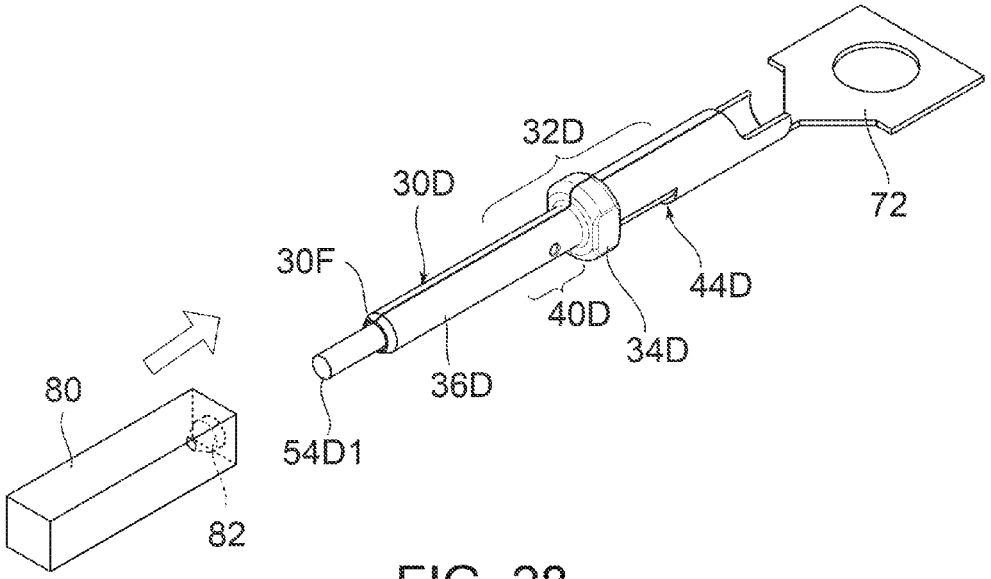
32D
30D
72
30F
44D
40D
34D
36D
80
54D1
82

FIG. 28

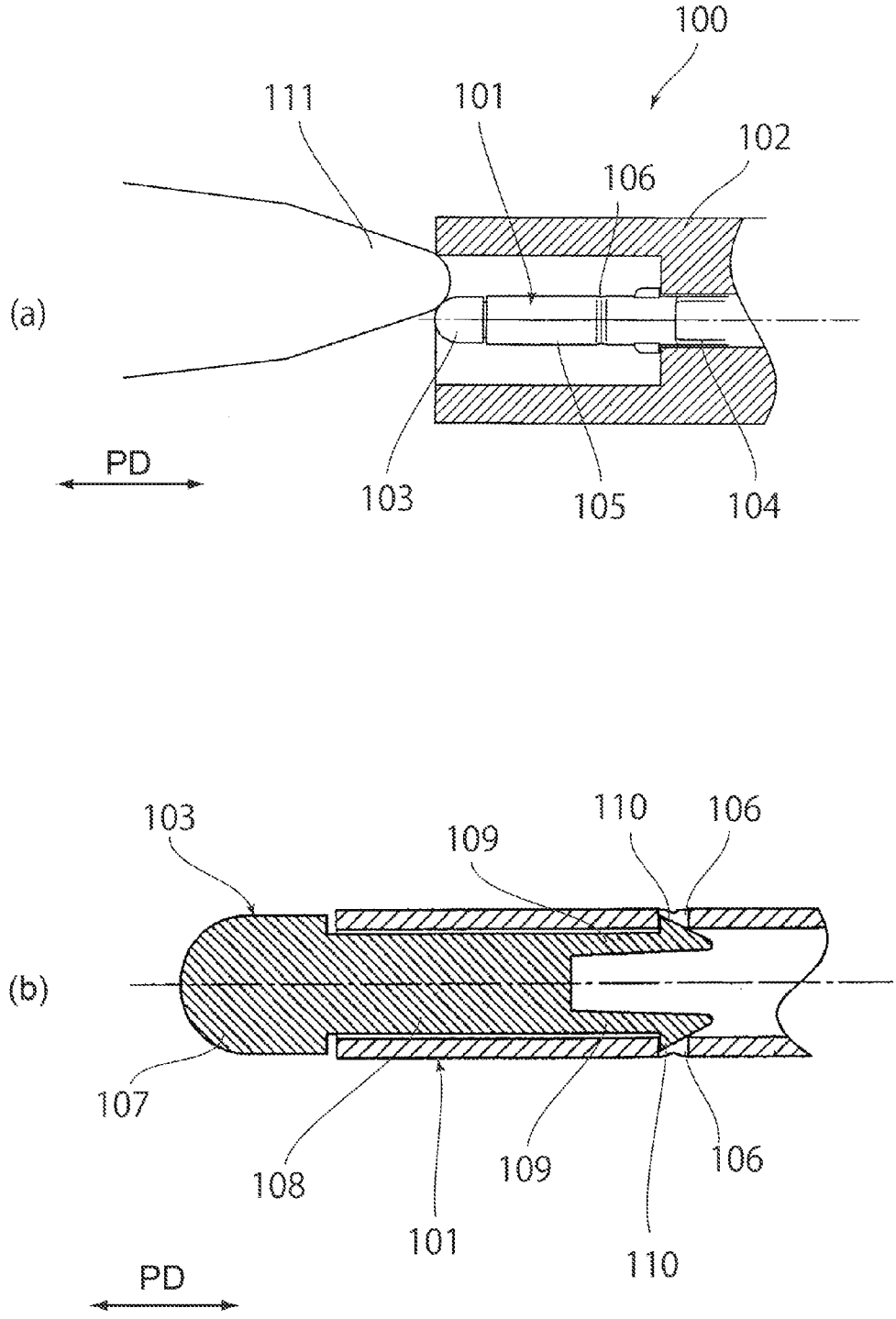

FIG. 29
PRIOR ART

CONNECTOR

CROSS REFERENCE TO RELATED APPLICATIONS

An applicant claims priority under 35 U.S.C. §119 of Japanese Patent Application No. JP2013-245042 filed Nov. 27, 2013 and Japanese Patent Application No. JP2014-133000 filed Jun. 27, 2014.

BACKGROUND OF THE INVENTION

This invention relates to a connector with a structure which prevents a finger of a user from being in contact with a tip of a contact.

As shown in FIG. **29**(*a*), a connector **100** of JP 3,575,295B comprises a contact **101**, a holding member **102** holding the contact **101**, and a contact prevention member **103** attached to the contact **101**. The contact **101** has a held portion **104** and a main portion **105**. The held portion **104** is held by the holding member **102**. The main portion **105** roughly has a tubular shape and extends from the held portion **104** in a predetermined direction (PD). As shown in FIG. **29**(*b*), the main portion **105** is formed with holes **106**, each of which pierces the main portion **105** in a radius direction perpendicular to the predetermined direction. The contact prevention member **103** has a head portion **107**, a shaft portion **108** and resilient portions **109**. The head portion **107** is larger than an inner shape of the main portion **105**. The shaft portion **108** has a shape corresponding to the inner shape of the main portion **105**. Each of the resilient portions **109** extends from the shaft portion **108**. An end of each resilient portion **109** is formed with an engagement portion **110** which projects outwards beyond the shaft portion **108** in the radius direction. When the contact prevention member **103** is inserted into the contact **101**, the engagement portions **110** of the contact prevention member **103** are engaged with the holes **106** of the main portion **105**. Thus, the contact prevention member **103** is attached to the contact **101**. The head portion **107** of the contact prevention member **103** projects over the tip of the contact **101** and prevents a finger **111** of a user from being in contact with the tip of the contact **101**.

The contact sometimes receives a force obliquely to the predetermined direction when the connector is mated with a mating connector. The connector of JP 3,575,295B has a problem that the contact might buckle when the contact receives the oblique force.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a connector with a structure which prevents a finger of a user from being in contact with a tip of a contact and according to which the contact buckles hardly even if the contact receives oblique force.

One aspect of the present invention provides a connector which is mateable with a mating connector along a predetermined direction (PD). The connector comprises a holding member, a plurality of contacts and a plurality of contact prevention members. The holding member includes a holding portion. The plurality of contacts include held portions and main portions, respectively. The held portions are held by the holding portion. The main portions extend from the held portions, respectively, in the predetermined direction. The main portions project over the holding portion in the predetermined direction. Each of the main portions has a tubular shape. Each of the contact prevention members is made of insulator. The contact prevention members occupy insides of the main portions, respectively. The contact prevention members project over the main portions, respectively, in the predetermined direction.

The contact prevention member occupies the inside of the main portion and projects over the main portion. Since the contact prevention member projects over the main portion, a finger of a user can be prevented from being in contact with the tip of the contact. Since the main portion is reinforced from inside thereof by the contact prevention member, the contact buckles hardly.

An appreciation of the objectives of the present invention and a more complete understanding of its structure may be had by studying the following description of the preferred embodiment and by referring to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view showing a connector according to a first embodiment of the present invention.

FIG. **2** is a cross-sectional view showing the connector of FIG. **1**.

FIG. **3** is a perspective view showing a contact and a contact prevention member which are included in the connector of FIG. **1**.

FIG. **4** is a cross-sectional view showing the contact and the contact prevention member of FIG. **3**. The contact is not yet formed with a crimped portion.

FIG. **5** is a perspective view showing a state before assembling the contact and the contact prevention member of FIG. **3**.

FIG. **6** is a perspective view showing the contact and the contact prevention member of FIG. **5**. The contact prevention member is inserted into the contact. The contact is not yet formed with the crimped portion.

FIG. **7** is a perspective view showing a connector according to a second embodiment of the present invention.

FIG. **8** is a cross-sectional view showing the connector of FIG. **7**.

FIG. **9** is a perspective view showing a contact and a contact prevention member which are included in the connector of FIG. **7**.

FIG. **10** is a cross-sectional view showing the contact and the contact prevention member of FIG. **9**. The contact is not yet formed with the crimped portion.

FIG. **11** is a perspective view showing a state before assembling the contact and the contact prevention member of FIG. **9**.

FIG. **12** is a perspective view showing the contact and the contact prevention member of FIG. **11**. The contact prevention member is inserted into the contact. The contact is not yet formed with the crimped portion.

FIG. **13** is a perspective view showing a connector according to a third embodiment of the present invention.

FIG. **14** is a cross-sectional view showing the connector of FIG. **13**.

FIG. **15** is a perspective view showing a contact and a contact prevention member which are included in the connector of FIG. **13**.

FIG. **16** is a cross-sectional view showing the contact and the contact prevention member of FIG. **15**. The contact is not yet formed with the crimped portion.

FIG. **17** is a perspective view showing a state before assembling the contact and the contact prevention member of FIG. **15**. The contact is in a state of an intermediate member.

FIG. **18** is a perspective view showing the intermediate member and the contact prevention member of FIG. **17**. The contact prevention member is mounted on the intermediate member.

FIG. **19** is a perspective view showing the intermediate member and the contact prevention member of FIG. **18**. The intermediate member is wound on the contact prevention member.

FIG. **20** is a perspective view showing a connector according to a modification in which a surrounding portion of the connector of FIG. **1** is formed of an insulator.

FIG. **21** is a cross-sectional view showing the connector of FIG. **20**.

FIG. **22** is a perspective view showing a connector according to a fourth embodiment of the present invention.

FIG. **23** is a cross-sectional view showing the connector of FIG. **22**.

FIG. **24** is a perspective view showing a contact and a contact prevention member which are included in the connector of FIG. **22**.

FIG. **25** is a cross-sectional view showing the contact and the contact prevention member of FIG. **24**.

FIG. **26** is an enlarged, cross-sectional view showing a tip of the contact and the contact prevention member of FIG. **25**.

FIG. **27** is a perspective view showing a state before assembling the contact and the contact prevention member of FIG. **24**. The contact prevention member is not yet formed with a large shape portion.

FIG. **28** is a perspective view showing a state following the state of FIG. **27**. The contact is formed with the crimped portion.

FIG. **29** is a cross-sectional view showing a connector of JP 3,575,295B. FIG. **29** (*a*) is a cross-sectional view showing the connector. FIG. **29** (*b*) is an enlarged, cross-sectional view showing the contact and the contact prevention member of FIG. **29** (*a*).

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the present invention as defined by the appended claims.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIGS. **1** and **2**, a connector **10** according to a first embodiment of the present invention is mateable with a mating connector (not shown) along a predetermined direction (front-rear direction, PD). The connector **10** has a mating end **12** and a receiving portion **14**. The mating end **12** is mateable with the mating connector. The receiving portion **14** receives a part of the mating connector. The mating end **12** is positioned at a front end of the connector **10**. The receiving portion **14** is positioned rearward of the mating end **12**. Specifically, the receiving portion **14** is recessed rearward from the mating end **12**.

The illustrated connector **10** comprises a holding member **20**, a plurality of contacts **30**, a plurality of contact prevention members **50** and a shell **60**. The holding member **20** is made of insulator. Each of the contacts **30** is made of conductor. Each of the contact prevention members **50** is made of insulator. The shell **60** is made of metal.

As shown in FIG. **2**, the holding member **20** includes a holding portion **22** which consists of two blocks, a front block **24** and a rear block **26**. The holding portion **22** may consist of one block.

As shown in FIGS. **1** to **4**, each of the contacts **30** includes a held portion **32** and a main portion **36**. The held portion **32** is held by the holding portion **22**. The main portion **36** projects over the held portion **32** in the predetermined direction. In detail, the main portion **36** of the present embodiment extends frontward so as to project over the holding portion **22** in the predetermined direction. As shown in FIGS. **2** to **4**, the held portion **32** is formed with a stopper portion **34** projecting in a radial direction. In the present embodiment, the stopper portion **34** is caught by the front block **24** and the rear block **26** as shown in FIG. **2**, so that the held portion **32** is held by the holding portion **22**. Furthermore, the stopper portion **34** is provided with a plane portion **34'**, so that the contact **30** can be prevented from being rotated. The main portion **36** has a tubular shape. Especially, the main portion **36** of the present embodiment has a cross-sectional shape uniform in a plane perpendicular to the predetermined direction.

The main portion **36** of the contact **30** is a part which is connected to a mating contact (not shown) of the mating connector (not shown). On the other hand, a rear part (including the held portion **32**) of the contact **30** is a connection portion which is connected to a signal line. Although the main portion **36** of the present embodiment has a cylindrical tubular shape, the present invention is not limited thereto. Depending upon a shape or the like of the mating contact (not shown) of the mating connector (not shown), the main portion **36** may have a square tubular shape. In addition, as understood from FIG. **4**, each of the contacts **30** of the present embodiment has a hollow structure in which a hole pierces it from its front end **30**F to its rear end **30**R. However, the present invention is not limited thereto. For example, each of the contacts **30** may have a partition wall which separates the main portion **36** from the connection portion (the rear part of the contact **30**).

Unlike the connector of JP 3,575,295B, each of the main portions **36** of the present embodiment is formed with no hole which connects between an inside and an outside of the main portion **36**, as understood from FIGS. **3** and **4**. Accordingly, when the signal line is connected to the contact **30** by soldering, molten solder flowing through an inside of the connection portion cannot flow out to an outer surface of the main portion **36** as a contact portion which connects the mating contact (not shown). Although each of the contacts **30** of the present embodiment is formed with no hole which connects between the outside and the inside thereof, each of the connection portions of the contacts **30** may be formed with the hole if each of the main portions **36** of the contacts **30** is formed with no hole.

As shown in FIGS. **4** and **5**, each of the contact prevention members **50** of the present embodiment has a head portion **52** and a shaft portion **54**. The shaft portion **54** extends along the predetermined direction (front-rear direction). Except a portion which is crimped to be deformed as described later, the shaft portion **54** has a bar-like shape having a size uniform in the plane perpendicular to the predetermined direction. The head portion **52** is formed at a front end of the shaft portion **54**. The head portion **52** has a shape (large shape portion) larger than the shaft portion **54** in the plane

perpendicular to the predetermined direction. In detail, as understood from FIGS. **3** and **4**, a maximum size of the head portion **52** is almost same as an outer peripheral size of the main portion **36**. Specifically, the head portions (large shape portions) **52** project outwards beyond shapes which are defined by inner walls of the main portions **36** in the plane perpendicular to the predetermined direction, respectively. The shaft portions **54** are accommodated in the contacts **30**, respectively. The head portions **52** project frontward from the front ends **30**F of the main portions **36**, respectively.

As best illustrated in FIG. **3**, each of parts of the contacts **30** is crimped to be formed with crimped portions **40**, so that the contact prevention members **50** of the present embodiment are attached to the contacts **30**, respectively. In detail, as understood from FIGS. **5** and **6**, the shaft portions **54** are inserted from the front ends **30**F of the contacts **30** into the main portions **36**, respectively, and regions **42** are then crimped to be deformed, so that the crimped portions **40** are formed (see FIG. **3**). By the formation of the crimped portions **40**, parts of the shaft portions **54** are deformed so as to occupy inside of the crimped portions **40**, respectively. Accordingly, the contact prevention members **50** are held by the contacts **30**, respectively.

As understood from FIGS. **5** and **6**, each of the contact prevention members **50** of the present embodiment is provided with the large shape portion (head portion **52**), which is larger than the shaft portion **54**, only at one end of the shaft portion **54**. Accordingly, when the shaft portions **54** are inserted into the main portions **36**, respectively, unnecessary loads are not applied to the contact prevention members **50** and the contacts **30**, respectively, so that unintended deformations of the contact prevention members **50** and the contacts **30** can be prevented.

In addition, as understood from FIGS. **2** and **4**, the shaft portions **54** of the contact prevention members **50** occupy insides of the main portions **36**, respectively. In other words, insides of the main portions **36** of the contacts **30** are reinforced by the shaft portions **54**, respectively. Thus, the contacts **30** of the present embodiment buckle hardly.

As understood from FIGS. **2** and **3**, each of the crimped portions **40** of the present embodiment is formed on the held portions **32**. Accordingly, as shown in FIG. **1**, the crimped portions **40** are not exposed in the receiving portion **14**. Since each of the main portions **36** has a uniform shape as shown in FIGS. **2** and **3**, the contacts **30** of the present embodiment buckle hardly. However, the present invention is not limited thereto. Each of the crimped portions **40** may be formed so as to extend over from the held portion **32** to the main portion **36**. In other words, each crimped portion **40** may be formed to bridge the held portion **32** and the main portion **36**.

As shown in FIGS. **1** and **2**, the shell **60** partly covers the holding member **20**. The shell **60** has a surrounding portion **62** which surrounds the main portions **36** of the plurality of contacts **30** altogether in the plane perpendicular to the predetermined direction. The surrounding portion **62** of the present embodiment defines the receiving portion **14** while an end of the surrounding portion **62** forms the mating end **12**. Although the surrounding portion **62** is formed as a part of the shell **60** in the present embodiment, the surrounding portion **62** may be formed as a part of the holding member **20**. The surrounding portion **62** may be provided on both the holding member **20** and the shell **60**.

For example, with reference to FIGS. **20** and **21**, a variation of the connector **10**C comprises, instead of the shell **60** of the above-described embodiment, a surrounding portion **62**C made of insulator. Specifically, the connector **10**C comprises the plurality of contacts **30**, the holding member **20**, the surrounding portion **62**C made of insulator. Each of the contacts **30** has a structure same as the contact **30** of the above-described embodiment and is held by the holding member **20** as described above. The surrounding portion **62**C surrounds the main portions **36** of the plurality of contacts **30** altogether in the plane perpendicular to the predetermined direction. As understood from FIGS. **1** and **20**, similar to the surrounding portion **62** of the above-described embodiment, the surrounding portion **62**C of the present embodiment defines a receiving portion **14**C and an end of the surrounding portion **62**C forms a mating end **12**C. Specifically, similar to the receiving portion **14** of the above-described embodiment, the main portions **36** of the contacts **30** are positioned in the receiving portion **14**C which is defined by the surrounding portion **62**C of this variation. In addition, the surrounding portion **62**C may be formed integrally with the holding member **20**.

With reference to FIGS. **7** and **8**, a connector **10**A according to a second embodiment of the present invention is a variation example of the connector **10** of the above-described first embodiment. In FIGS. **7** and **8**, components which are same as those of the connector **10** shown in FIGS. **1** and **2** are referred by using reference signs same as those of the connector **10**. As understood from FIGS. **7** and **8**, the holding member **20** and the shell **60** of the present embodiment are same as the holding member **20** and the shell **60** of the first embodiment. Accordingly, detailed explanation about those components is not made. With reference to FIGS. **5** and **11**, each of contacts **30**A which is not yet crimped has a structure same as the contact **30** of the first embodiment which is not yet crimped. Accordingly, with reference to FIGS. **9** to **12**, a structure of a contact prevention member **50**A and an attachment method of the contact prevention member **50**A to the contact **30**A are mainly described below.

As shown in FIGS. **10** and **11**, each of the contact prevention members **50**A of the present embodiment has a shaft portion **54**A and a large shape portion **56**A. The shaft portion **54**A extends along the predetermined direction (front-rear direction). The shaft portion **54**A has a length longer than the shaft portion **54** of the above-described first embodiment in the predetermined direction. The shaft portion **54**A has a bar-like shape having a size uniform in the plane perpendicular to the predetermined direction. Parts of the shaft portions **54**A of the present embodiment project from the front ends **30**F of the contacts **30**A, respectively. The remaining parts of the shaft portions **54**A of the present embodiment are accommodated in the contacts **30**A, respectively. The large shape portion **56**A is provided on a rear end of the shaft portion **54**A. The large shape portion **56**A has a shape larger than the shaft portion **54**A in the plane perpendicular to the predetermined direction. The large shape portions **56**A are accommodated in the contacts **30**A, respectively.

As best illustrated in FIG. **9**, each of parts of the contacts **30**A is crimped to be formed with a crimped portion **40**A, so that contact prevention members **50**A of the present embodiment are attached to the contacts **30**A, respectively. In detail, as understood from FIGS. **11** and **12**, the shaft portions **54**A are inserted from the rear ends **30**R of the contacts **30**A into the main portions **36**, respectively, and regions **42**A are then crimped to be deformed, so that the crimped portions **40**A are formed (see FIG. **9**). By the formation of the crimped portions **40**A, parts of the large shape portion **56**A are deformed to occupy insides of the crimped portions **40**A, respectively, so that the contact prevention members **50**A are

held by the contacts **30**A, respectively. In addition, as shown in FIG. **3** of the first embodiment, each of the crimped portions **40**A may be formed at a part which is positioned frontward of the stopper portion **34**.

As understood from FIGS. **11** and **12**, each of the contact prevention members **50**A of the present embodiment is provided with the large shape portion **56**A, which is larger than the shaft portion **54**A, only at one end of the shaft portion **54**A. Accordingly, when the shaft portions **54**A are inserted into the contacts **30**A, respectively, unnecessary loads are not applied to the contact prevention members **50**A and the contacts **30**A, respectively, so that unintended deformations of the contact prevention members **50**A and the contacts **30**A can be prevented.

In addition, as understood from FIGS. **8** and **10**, the shaft portions **54**A of the contact prevention members **50**A occupy insides of the main portions **36** of the contacts **30**A, respectively. In other words, insides of the main portions **36** of the contacts **30**A are reinforced by the shaft portions **54**A, respectively. Thus, the contacts **30**A of the present embodiment buckle hardly.

As understood from FIGS. **8** and **9**, each of the crimped portions **40**A of the present embodiment is formed on the held portion **32**A. Each of the main portions **36** of the present embodiment has a uniform shape. Accordingly, the contacts **30**A of the present embodiment buckle hardly.

In the above-described first and second embodiment, the contacts **30**, **30**A are formed by cutting and the like. However, the present invention is not limited thereto. For example, in a third embodiment, each of contacts may be formed cylindrically by rolling a blank which is obtained by pressing a metal plate. The third embodiment is described below.

With reference to FIGS. **13** and **14**, a connector **10**B according to the third embodiment of the present invention is a variation example of the connector **10** of the above-described first embodiment. In FIGS. **13** and **14**, the portions which are same as those of the connector **10** shown in FIGS. **1** and **2** are referred by using reference signs same as those of the connector **10**. As understood from FIGS. **13** and **14**, the holding member **20** and the shell **60** of the present embodiment are same as the holding member **20** and the shell **60** of the first embodiment. Accordingly, detailed explanation about those portions is not made.

Although, as understood from FIGS. **14** to **16**, a main function of contacts **30**B is same as the above-described contacts **30**, **30**A, a manufacturing method of the contacts **30**B is different from those of the contacts **30**, **30**A. Because of the difference of the manufacturing methods, a structural detail of each of the contacts **30**B is different from those of the contacts **30**, **30**A.

As understood from FIGS. **15** to **19**, the contacts **30**B of the present embodiment are formed by winding intermediate members **70**, which are obtained by pressing metal plates, around contact prevention members **50**B, respectively. The intermediate members **70** are wound around the contact prevention members **50**B, respectively, so that the contact prevention members **50**B are held by the contacts **30**B, respectively.

With reference to FIGS. **16** to **18**, each of the contact prevention members **50**B of the present embodiment has a structure which has both features of the contact prevention member **50**B and the contact prevention member **50**A as described above. Each of the contact prevention members **50**B has a head portion (large shape portion) **52**B, a shaft portion **54**B and a large shape portion **56**B. The head portion **52**B corresponds to the head portion **52** of the contact prevention member **50**B of the first embodiment. The head portion **52**B is positioned frontward of the shaft portion **54**B. The large shape portion **56**B corresponds to the large shape portion **56**A of the contact prevention member **50**A of the second embodiment. The large shape portion **56**B is positioned rearward of the shaft portion **54**B. Specifically, in the predetermined direction, each of the contact prevention members **50**B of the present embodiment has the large shape portion **52**B on one end of the shaft portion **54**B and the large shape portion **56**B on the other end thereof. The large shape portions **52**B and **56**B have shapes each of which is larger than a shape of the shaft portion **54**B in the plane perpendicular to the predetermined direction.

As shown in FIG. **17**, each of the intermediate members **70** is formed with a portion **34**B' which becomes a stopper portion **34**B. The illustrated intermediate member **70** is under a state where the intermediate member **70** is connected to a carrier **72**. As shown in FIG. **18**, the contact prevention members **50**B are mounted on the intermediate members **70** so that the head portions **52**B project from front ends **30**F' of the intermediate members **70**, respectively, and that the large shape portions **56**B extend rearward from the portions **34**B', respectively. Specifically, the contact prevention members **50**B are mounted on the intermediate members **70** so that the shaft portions **54**B are positioned between the front ends **30**F' and the portions **34**B', respectively. Next, as shown in FIG. **19**, the intermediate members **70** are wound around the contact prevention members **50**B, respectively. Thus, the contact prevention members **50**B are held by the contacts **30**B, respectively. After that, the carriers **72** are separated from the contacts **30**B, respectively, so that the contact **30**B and the contact prevention member **50**B as shown in FIG. **15** are obtained.

By the above-described manufacturing method, each of the contacts **30**B has a joint **30**C. As shown in FIG. **16**, the shaft portions **54**B of the contact prevention members **50**B occupy insides of the main portions **36**B, respectively, and each of the contacts **30**B is formed with no hole which connects between an inside and an outside thereof. Accordingly, similar to the first embodiment and the second embodiment, molten solder cannot flow out to an outer surface of the contact **30**B when the signal line is connected to the contact **30**B by soldering. In addition, in the present embodiment, each of the connection portions of the contacts **30**B may be formed with the hole if each of the main portions **36**B of the contacts **30**B is not formed with the hole.

With reference to FIG. **16**, a space exists between the stopper portion **34**B and the large shape portion **56**B of the present embodiment. As shown in FIG. **14**, the stopper portion **34**B is a part of the held portion **32**B which is held by the holding portion **22**. Thus, the contacts **30**B buckle hardly even if the spaces exist. However, the present invention is not limited thereto. Each of the contact prevention members **50**B may be modified so that each of the spaces does not exist between the stopper portion **34**B and the contact prevention member **50**B.

By the above-described manufacturing method, the large shape portions **52**B and **56**B having shapes each of which is larger than an inner shape of the main portion **36**B can be provided at opposite ends of the tubular main portion **36**B, respectively. Accordingly, the contact prevention member **50**B are prevented from coming off from the contacts **30**B, respectively.

In the present embodiment, each of the contact prevention members **50**B having a size slightly larger than a normal size may be pressed to be compressed and deformed when the intermediate member **70** is wound therearound. In that case,

the contacts **30**B are engaged with the surface of the contact prevention members **50**B by winding the intermediate members **70**, respectively, so that the contact prevention members **50**B are held by the contacts **30**B, respectively. Accordingly, at least one of the head portion **52**B and the large shape portion **56**B can be omitted. In addition, similar to the first and second embodiment, at least one of the crimped portions **40**, **40**A may be formed on the contact **30**B.

With reference to FIGS. **22** and **23**, the connector **10**D according to a fourth embodiment of the present invention is a variation example of the connector **10** of the above-described first embodiment. In FIGS. **22** and **23**, components which are same as those of the connector **10** shown in FIGS. **1** and **2** are referred by using reference signs same as those of the connector **10**. As understood from FIGS. **22** and **23**, the holding member **20** and the shell **60** of the present embodiment are same as the holding member **20** and the shell **60** of the first embodiment. Accordingly, detailed explanation about those components is not made.

As understood from FIGS. **24** and **25**, each of the contacts **30**D of the present embodiment is obtained by pressing a metal plate followed by bending it. Each of the contacts **30**D of the present embodiment has a joint **30**C similar to the contact **30**B (see FIG. **15**) of the above-described embodiment. However, the present invention is not limited thereto. Each of the contacts **30**D may be formed by cutting and the like.

Specifically, as shown in FIGS. **24** and **25**, each of the contacts **30**D has a held portion **32**D and a main portion **36**D. The held portion **32**D is held by the holding portion **22**. The main portion **36**D extends from the held portion **32**D in the predetermined direction. In detail, the main portion **36**D of the present embodiment extends frontward so as to project over the holding portion **22** in the predetermined direction. As shown in FIGS. **23** to **25**, the held portion **32**D is formed with a stopper portion **34**D projecting in the radial direction. In the present embodiment, as shown in FIG. **23**, the stopper portion **34**D is caught by the front block **24** and the rear block **26** as shown in FIG. **23**, so that the held portion **32**D is held by the holding portion **22**. The main portion **36**D has a tubular shape. Except a portion which is crimped to be deformed as described later, the main portion **36**D of the present embodiment has a cross-sectional shape uniform in the plane perpendicular to the predetermined direction. As best illustrated in FIG. **25**, each of the contacts **30**D is formed with a partition portion **44**D which separates solder from the contact prevention member **50**D so that the solder is prevented from being adhered to the contact prevention member **50**D when the signal line is connected to the contact **30**D by soldering. Each of the contact prevention members **50**D is described later. In the present embodiment, the partition portion **44**D is positioned rearward of the stopper portion **34**D.

As shown in FIGS. **25** and **26**, each of the contact prevention members **50**D of the present embodiment has a head portion (large shape portion) **52**D, an inner fit portion **56**D and a shaft portion **54**D. The shaft portion **54**D extends along the predetermined direction (front-rear direction). Except a portion which is crimped to be deformed as described later, the shaft portion **54**D has a bar-like shape having a size uniform in the plane perpendicular to the predetermined direction. Especially, in the plane (perpendicular plane) perpendicular to the predetermined direction, the shaft portion **54**D of the present embodiment has a size smaller than a shape which is defined by an inner wall **38**D of the main portion **36**D of the contact **30**D. Accordingly, as shown in FIG. **26**, a slight space exists between the inner wall **38**D of the main portion **36**D and the shaft portion **54**D, and the shaft portion **54**D is not closely fit on the inner wall **38**D. The inner fit portion **56**D is provided on a front end of the shaft portion **54**D. The inner fit portion **56**D has a size larger than the shaft portion **54**D in the perpendicular plane. In other words, the shaft portion **54**D has a size smaller than the inner fit portion **56**D in the perpendicular plane. Specifically, the inner fit portion **56**D is closely fit on the whole inner wall **38**D of the main portion **36**D in the perpendicular plane. The head portion **52**D is provided on a front end of the inner fit portion **56**D. Specifically, the inner fit portion **56**D is positioned between the head portion **52**D and the shaft portion **54**D in the predetermined direction. The head portion **52**D of the present embodiment is in contact with the main portion **36**D without any gaps in the predetermined direction. In other words, the head portion **52**D is in contact with a whole circumference of an end of the main portion **36**D. Furthermore, the head portion **52**D has a size larger than the inner fit portion **56**D in the perpendicular plane. Specifically, the head portion **52**D has a size larger than the shaft portion **54**D in the perpendicular plane. In detail, as understood from FIGS. **25** and **26**, the head portion (large shape portion) **52**D projects outwards beyond a shape which is defined by the inner wall **38**D of the main portion **36**D in the perpendicular plane. The inner fit portion **56**D and the shaft portion **54**D are accommodated in the contact **30**D. The head portion **52**D projects frontward from the front end **30**F of the main portion **36**D.

In the present embodiment, the shaft portion **54**D has the bar-like shape having a cross-sectional shape uniform in the perpendicular plane. Accordingly, an end of each of the contact prevention members **50**D of the present embodiment opposite to the head portion **52**D thereof has a size smaller than a shape which is defined by the inner wall **38**D of the main portion **36**D in the perpendicular plane. Specifically, each of the contact prevention members **50**D of the present embodiment is formed with a large shape portion (head portion **52**D) only at one end in the predetermine direction, wherein the large shape portion (head portion **52**D) projects outwards beyond a shape which is defined by the inner wall **38**D of the main portion **36**D in the perpendicular plane.

As shown in FIGS. **27** and **28**, each of the contact prevention members **50**D of the present embodiment is formed by thermally welding a rod material **54**D**1** made of resin by use of a jig **80**. The illustrated contact **30**D is connected to the carrier **72**. The carrier **72** holds the contact **30**D upon formation of the contact prevention member **50**D.

In detail, with reference to FIG. **27**, after a continuously-formed, long rod material **54**D**1** is inserted into the main portion **36**D of the contact **30**D, the rod material **54**D**1** is cut so as to have a predetermined length. Alternatively, the rod material **54**D**1** may be first cut to have the predetermined length, and then may be inserted into the main portion **36**D of the contact **30**D. Thereafter, a part of the contact **30**D is crimped to form a crimped portion **40**D, so that the rod material **54**D**1** is fixed so as not to be moved in the predetermined direction. In this state, as shown in FIG. **28**, an end of the rod material **54**D**1** projects frontward from the front end **30**F of the contact **30**D, and the head portion **52**D is then formed by using the jig **80**. The jig **80** is formed with a recess **82** which has a shape corresponding to a shape of the head portion **52**D. After the jig **80** is heated over a melting point of the rod material **54**D**1**, the heated jig **80** is pressed against the end of the rod material **54**D**1**. Accordingly, the head portion **52**D is formed while an excess resin is pushed into the main portion **36**D so that the inner fit portion **56**D is formed. In other words, the contact preven-

tion member **50**D is formed by the above-described process. After that, the carrier **72** is separated from the contact **30**D.

In the above-described heating process with using the jig **80**, the head portion **52**D is closely fit on the front end **30**F of the contact **30**D in the predetermined direction while the inner fit portion **56**D is closely fit on the inner wall **38**D of the main portion **36**D. Accordingly, looseness of the contact prevention member **50**D (especially, the head portions **52**D and the vicinities thereof) against the contact **30**D can be suppressed.

In the above-described manufacturing method, the rod material **54**D**1** is inserted into the contact **30**D and then a part of the contact **30**D is crimped so that a position of the rod material **54**D**1** with respect to the contact **30**D is fixed. However, the present invention is not limited thereto. For example, the contact **30**D may be provided with a projection on its inside, and then the rod material **54**D**1** may be press-fitted into the contact **30**D so that a position of the rod material **54**D**1** with respect to the contact **30**D is fixed.

Instead of the rod material **54**D**1** having a simple shape, for example, a premolded insulator, such as the contact prevention member **50**A as shown in FIG. **11**, can be used. In that case, after the insulator is inserted into the contact **30**A as shown in FIG. **12**, the crimped portion **40**A (see FIG. **9**) is formed, and the jig **80** is then pressed against the insulator as shown in FIG. **28**, so that the head portion **52**D (large shape portion) is formed. In the above-described process, instead of forming the crimped portion **40**A and pressing the jig **80** against the insulator, the jig **80** may be pressed against the insulator as shown in FIG. **28** in a state where movement of the insulator is restricted by pressing a rear part of the large shape portion **56**A (see FIG. **11**). In this case, similar to the third embodiment, the large shape portions are formed at opposite ends of the contact prevention member, respectively. Nonetheless, the contact prevention member **50**D has the large shape portion only at one end thereof. The contact prevention member **50**D can be formed by using a resin rod having a simple shape and can be formed by the above-described manufacturing method suitable for automatization. Accordingly, the contact **30**D including the contact prevention member **50**D having the large shape portion only at one end thereof is advantageous in cost.

The above-described connectors **10**, **10**A, **10**B and **10**D are especially useful for a medical equipment which requires that a finger of a user is prevented from being brought into contact with tips of the contacts **30**, **30**A, **30**B and **30**D whose diameters are small.

The present application is based on Japanese patent applications of JP2013-245042 and JP2014-133000 filed before the Japan Patent Office on Nov. 27, 2013 and Jun. 27, 2014, respectively, the contents of which are incorporated herein by references.

While there has been described what is believed to be the preferred embodiment of the invention, those skilled in the art will recognize that other and further modifications may be made thereto without departing from the spirit of the invention, and it is intended to claim all such embodiments that fall within the true scope of the invention.

What is claimed is:

1. A connector mateable with a mating connector along a predetermined direction, the connector comprising:

a holding member;

a plurality of contacts; and

a plurality of contact prevention members;

wherein:

the holding member includes a holding portion;

the contacts include held portions and main portions, respectively;

the whole of each of the held portions is held by the holding portion;

the main portions extend from the held portions, respectively, in the predetermined direction;

the main portions project over the holding portion in the predetermined direction;

each of the main portions has a tubular shape;

each of the contact prevention members is made of an insulator;

the contact prevention members extend in the insides of the main portions so as to occupy all of a length of each of the main portions, respectively, in the predetermined direction;

the contact prevention members project over the main portions, respectively, in the predetermined direction;

each of the main portions has an inner wall which defines a predetermined shape in a perpendicular plane perpendicular to the predetermined direction;

each of the contact prevention members has a lame shape portion which projects over the main portion in the predetermined direction;

the large shape portion is a thermal welded portion which projects outwards beyond the predetermined shape in the perpendicular plane;

each of the contact prevention members further has an inner fit portion and a shaft portion;

the lame shape portion is in contact with the main portion without any gaps therebetween in the predetermined direction;

the inner fit portion is positioned between the lame shape portion and the shaft portion in the predetermined direction;

the inner fit portion is closely fit on the whole inner wall of the main portion in the perpendicular plane; and

the shaft portion has a size smaller than the inner fit portion in the perpendicular plane.

2. The connector as recited in claim **1**, wherein each of the main portions is formed with no hole which connects between an inside and an outside of the main portion in a direction perpendicular to the predetermined direction.

3. The connector as recited in claim **1**, wherein each of the main portions has a cross-sectional shape uniform in a plane perpendicular to the predetermined direction.

4. The connector as recited in claim **1**, wherein each of the contacts is formed with a crimped portion which holds the contact prevention member.

5. The connector as recited in claim **4**, wherein the crimped portion is formed on the held portion.

6. The connector as recited in claim **4**, wherein:

each of the contact prevention members has two ends in the predetermined direction; and

only one of the two ends of each of the contact prevention members is formed with the large shape portion which projects outwards beyond the predetermined shape in the perpendicular plane.

7. The connector as recited in claim **1**, wherein each of the contacts is a pressed member which is wound on the contact prevention member.

8. The connector as recited in claim **7**, wherein:

each of the contact prevention members has two ends in the predetermined direction; and

each of the two ends of each of the contact prevention members is formed with the large shape portion which projects outwards beyond the predetermined shape in the perpendicular plane.

9. The connector as recited in claim 1, wherein each of the contact prevention members has another end which is not formed with the large shape portion and which is smaller than the predetermined shape in the perpendicular plane.

10. The connector as recited in claim 1, further comprising a shell made of metal, wherein the shell surrounds the main portions of the plurality of contacts altogether in a plane perpendicular to the predetermined direction.

11. The connector as recited in claim 1, wherein:

the holding member has a surrounding portion which extends from the holding portion; and

the surrounding portion surrounds the main portions of the plurality of contacts altogether in a plane perpendicular to the predetermined direction.

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